Energy and urban planning

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Energy and urban planning

How can spatial planning reduce energy use in our cities? How do different geographical, regional, cultural or political contexts influence our options? How can we measure and monitor its effects? And where do we set the boundaries for the definition of action and goals? Findings from the international EU-FP7 project PLEEC ('Planning for energy efficient cities', 2013-2016) and spin-off projects list options and challenges.

Related projects:
PLEEC - Planning for energy efficient cities
EU-FP7, www.pleecproject.eu, 2013-2016
Energy-Smart Cities-DK
2014
Energy efficient urban planning
PhD project, 2014-2017

(1) How can spatial planning reduce energy use in our cities?

A list with 29 measures.

Based on a thematic review done in PLEEC (Meijers et al., 2015) a number of tools and approaches towards urban energy planning was introduced. We focus on the three main sectors of energy consumption (buildings, industry and transport) and in a fourth section on aspects of urban energy generation. After a round of comments from the six city partners* we finalized a list of 29 measures and policies related to spatial planning to influence urban energy.

	Goal	Measure / policy
Buildings and built environment	A. Optimize energy distribution on district level	A1. Incorporate energy efficiency considerations into general strategic spatial development plan(s), probably considering the city-regional scale (e.g. the project 'Heat Road Map Europe 2050' recommends the combination of district heating in dense urban areas and heat pumps in scattered built up areas.)
		A2. Energy plan for the housing estate (The planning of new housing estates should be accompanied by an energy plan according to which decisions on energy supply (e.g. DH, HP, SP, SC) and energy efficiency of the buildings (e.g. insulation) are settled.)
		A3. Promote apartment buildings and dense housing, limited detached housing (An otherwise identical household consumes 54% less heating energy in an apartment than in a single-family home, tough the gap is narrowing due to new building regulations.)
		A4. Densify existing built-up areas (can reduce infrastructure costs per person)
		A5. Build more compact urban forms: less wide streets, less distance between buildings. (can reduce infrastructure costs per person)
	B. Climate-oriented urban design	B1. Translate general measures in such a way that the local urban and climate-specific context are utilised to the max. (Climate-conscious development: adapt general strategies to specific climatic circumstances.)
		B2. Optimise solar access / shading (trees, streets and building orientation) (What is optimal depends on the latitude and climate. There are some rules of thumb, e.g. on housing orientation and tree planting, however, often compromises with other urban design considerations have to be found – What do you prioritize?)
		B3. Optimise wind ventilation / wind blocking (trees and buildings) (Again this depends on the climate, but also on the surrounding topography. Height and density of buildings can affects possibilities for wind ventilation or protection from cold winds. Particularly useful in warmer climates, but less in colder climates, where this may lead to a blocking of solar access. In colder climates, planting trees to the north, or to block winds, can be beneficial as well.)
Transportation	C. Reduce travel needs	C1. Promote larger settlements to provide opportunities for self-containment and a good mix of uses. (Larger urban areas provide more opportunities to reduce the need to travel, and to use energy-efficient transport modes. Expansion of larger urban areas is generally preferable to development in smaller towns or dispersing development across a number of smaller settlements.)
		C2. New development should ideally be located within or immediately adjacent to larger towns and cities.
		C3. Foster mixed use development. Key local (neighbourhood) facilities and services should be located within walking distance of homes in a neighbourhood. (This not only reduces travel distances (and hence, encourages walking and cycling), but also provides support for shops and services to remain economically viable.)
		C4. Relocate transport intensive industries or power plants (e.g. power plants using biomass to decrease the energy consumption in transport, in Eskilstuna it was estimated that 57% of lorry-rides to bring biomass inputs would be replaced by rail).
	D. Promote 'green' transport	D1. Locate major new urban developments (employment, leisure, retail, housing) near public transport nodes and/or close to existing centres (Transit oriented development)
		D2. Locate key services and facilities that serve the entire city or region (shopping centres, hospitals, libraries, educational institutions etc.) within the urban fabric and make sure they are very well accessible by public transport.
		D3. Develop intermodal transport nodes in combination with urban development
		D4. Increase density of development, particularly in areas adjacent to major public transport nodes (Rule of thumb: 10-minute walk, 800 meter radius; this should be consistent with local norms, accommodation needs and liveability objectives.)
		D5. Develop key public transport networks in urban areas
		D6. Develop walking and cycling infrastructure (pavements, shortcuts, separate cycling lanes, parking facilities for bikes).
		D7. Increase the 'permeability' of the network of streets to encourage walking, cycling and public transport use. (Also pay attention to social safety.)
		D8. Avoid development locations that promote long-distance journeys by car.
		D9. Imposit maximum parking standards (parking management)
Industrial	E. Enable industrial symbiosis by spatial clustering of industrial activities	E1. Clustering in space of industrial activities with complementary energy and waste material outputs and inputs to achieve industrial symbiosis. (Very substantial benefits, not just in terms of energy saving, but for instance also in terms of CO2 reduction. Case studies suggest that fuel efficiency doubles.)
	F. Improve opportunities for co-generation and linkages to district energy systems	F1. Spatial clustering of industries to improve opportunities for co-generation of energy and/or support district heating systems (Scale advantages in energy generation, and district heating systems are more feasible in case there is a big industrial consumer present)
		F2. Encouraging heavy energy consuming industries to introduce combined heat and power and/or to combine with local district heating/cooling
Energy generation	G. Optimise energy distribution systems	G1. Implement district energy systems to profit from combined heat and power production (CHP). (Local (district) heating systems help utilize heat production from waste incineration and industrial excess heat production, as well as integration of geothermal/wind/biogas/biomass production. In Turku, the CHP plant cuts fuel consumption by one-third. Energy costs for firms in Stoke are expected to decrease by 10%.)
	H. Designate areas for renewable energy production	H1. Designate areas for large-scale production sites of hydro/wind/solar/geothermal/ biomass/ biogas energy generation.
		H2. Introduce heat pumps in public works whenever excess heating is available (e.g. waste-water) combined with district cooling when relevant.
	I. Enable small-scale (households) renewable energy generation	I1. Implement planning guidelines to optimise solar access of houses to foster households' use of solar panels. (See measures B)
		I2. Remove institutional and legal local barriers for household-scale production of energy (heat pumps, solar).

List of spatial planning measures influencing energy use.

(2) How do different geographical, regional, cultural or political contexts influence options?

The baseline for actions.

Every measure can only work when it relates to the local/regional context, which is framing a city's possibilities for the implementation of measures. This includes the legal system, cultural differences or behavioural preferences. In PLEEC we focused in particular on differences in urban structure, that means its spatial functioning and management.

The six PLEEC partner cities are very different in this regard. E.g. Santiago and Tartu are rather small and far away from big cities, while Eskilstuna is close to Stockholm and Stoke-on-Trent is located between Liverpool, Manchester and Birmingham. This structure is decisive for transport and commuting.

Also the coverage of the municipal territory is crucial. Eskilstuna and (partially) Jyväskylä cover the main city and its closer hinterland . Tartu and Santiago are strictly confined to the central build-up area . Stoke-on-Trent and Turku have even the continuous built-up area shared between several local administrations.

Jyväskylä
Turku
Eskilstuna
Tartu
Stoke-on-Trent
Santiago de Compostela

Table 2: Final energy consumption per capita, in MWh

Municipality	in city	National average
Eskilstuna	26.5	39.4
Jyväskylä	28.0	54.1
Santiago	9.7*	20.7
Stoke	16.4	24.4
Tartu	13.0	25.3
Turku	35.3	54.1

Data sources: Cities: (Giffinger, Hemis, Weninger, & Haindlmaier, 2014); Countries: Eurostat 2012
* Excluding transport (National energy consumption per capita in Spain excluding transport is 12.4 MWh)

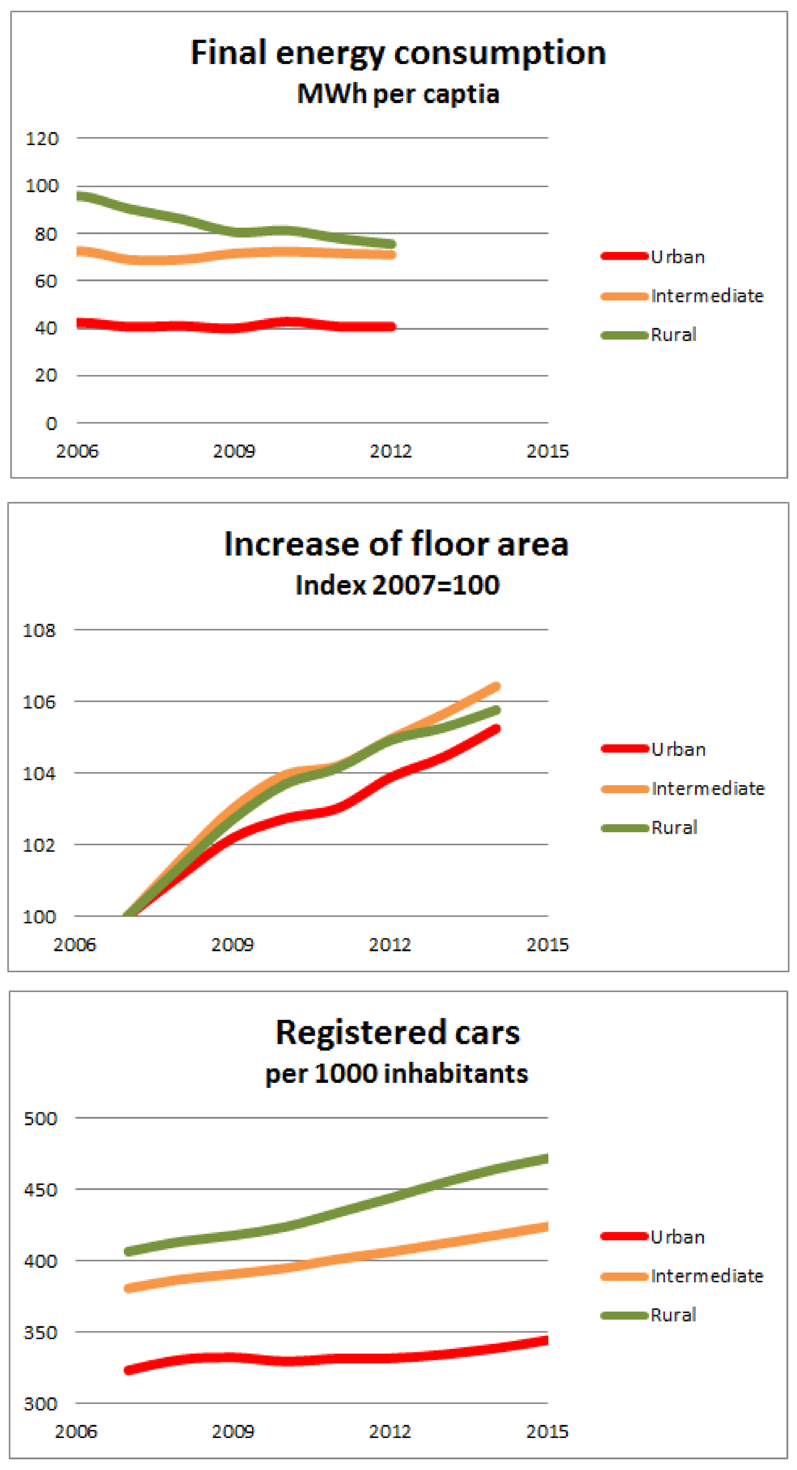
(3) How can we measure and monitor its effects?

Indicators and rebound effects.

In PLEEC an indicator framework ('Energy-Smart Cities-Model') to monitor the energy performance of cities was developed including about 50 indicators. Based on that, we analysed and benchmarked the energy situation of Danish municipalities in a spin-off project called 'Energy-Smart Cities-DK', financed by NRGi/Kuben Management (Fertner & Groth 2015).

Energy consumption has been reduced in the recent decade, especially in rural areas, although urban areas are still using least energy per capita. Technical infrastructure for heating is advanced. District heating is steadily increasing, covering more than 60 % of all households and heat pumps are increasingly popular in rural areas (3 %). However, there are also some counteracting trends. Floor area is increasing, more than population. And although Denmark has a well functioning public transport system and a strong cycling culture, car transport is stable or even increasing. The average km per car (vkm) are decreasing in urban areas, however, the number of cars is increasing in the same time.

These are partially rebound effects (Fertner & Große 2015), where the efficiency gains by improving one system are out-balanced by the use of these (energy in our case) in another system. A major question is therefore the scope of e.g. a municipal energy action plan.



Trends in urban, intermediate and rural municipalities in Denmark.

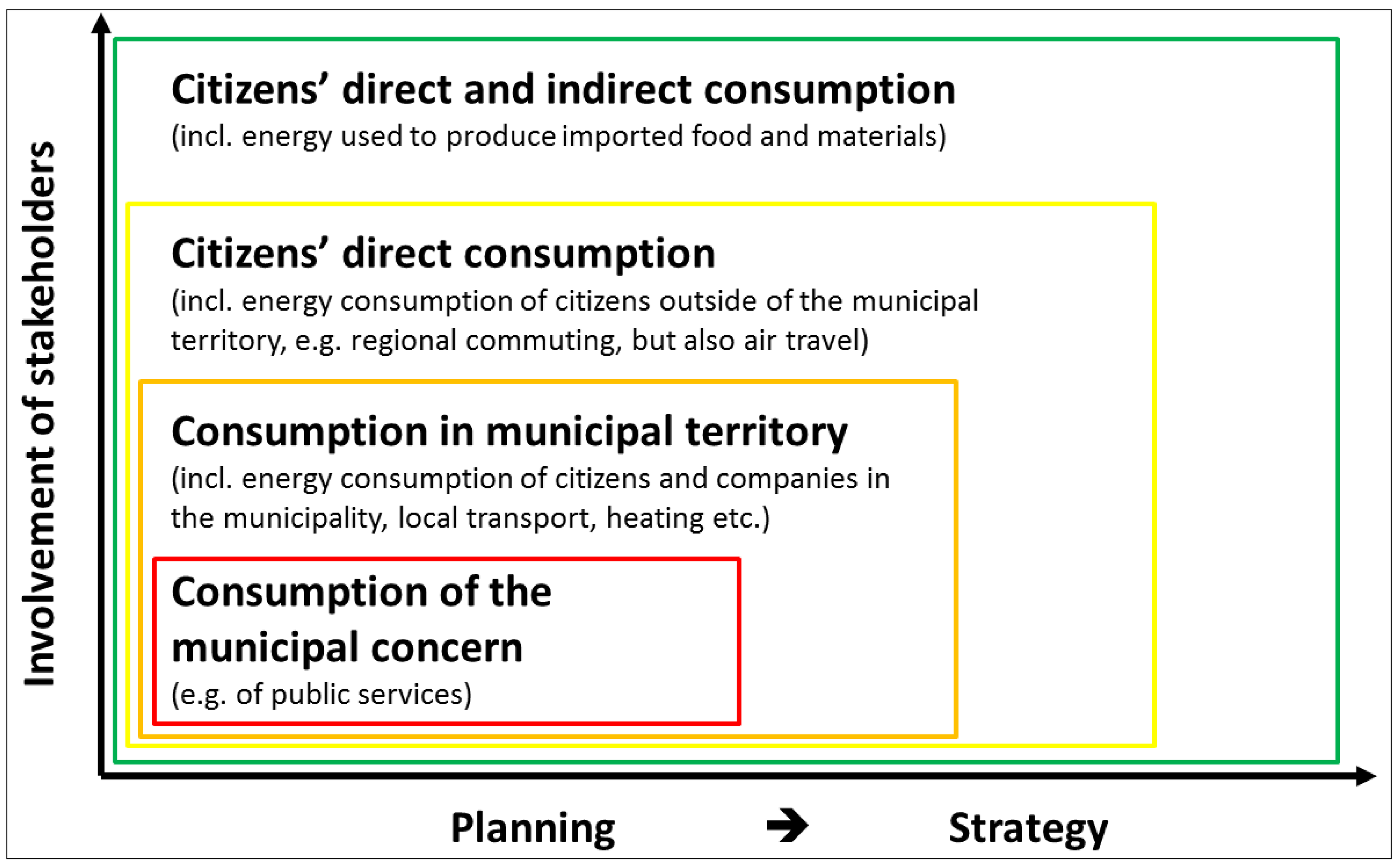
(4) What is the scope of municipal action?

Drawing system boundaries.

When the City of Copenhagen will be carbon neutral in 2025 (following their current plans) we will have come a big step forward. However, energy is not only consumed directly (e.g. in the form of electricity or fuel).

The largest portion of energy which is consumed by citizens in the developed world is consumed indirectly, that means e.g. in the form of material or food, which consumed energy and emitted green house gases during the production process.

The figure below shows different arenas wherein a municipality can act. The most efficient actions can be achieved in the municipal concern, however, if we aim at long term sustainable development it is crucial to work with citizen's direct and indirect energy consumption.



What should be the scope of municipal actions regarding energy consumption (for example in a Sustainable Energy Action Plan) ?

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